SHOULD WE PACK MORE CHANNELS IN ?

A SPECULATIVE PROPOSAL FOR 12·5KHZ CHANNEL SPACING ON 144MHZ

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For some while there has been talk in the amateur radio movement about fm channel spacing, and whether we ought to adopt a 12·5kHz spacing standard rather than the currently-used 25kHz spacing standard. When fm usage went through its rapid expansion in the early 70's, the 25kHz standard was adopted because it was commercial practice in Europe, and much surplus equipment was already set up for it. Now that commercial users have switched to 12·5kHz several years ago, it is only natural that amateurs should consider following suit.

Things, however, are not that straightforward. There is a very large number of fm rigs in the field working to the 25kHz standard, and it is not certain what difficulties would be caused in effecting a change. It would certainly provide more channels, easing congestion, but what of performance? Rumours have abounded that 12·5kHz is 3dB worse than 25kHz, but others argue the reverse!

Would it be possible for the two standards to co-exist with a minimum of mutual problems between them? One thing is certain – the problems facing amateurs are quite different from those solved in the professional field.

With all this uncertainty, the VHF Committee recently decided to initiate an in-depth study into the whole problem, and asked Angus McKenzie to lead it. This report represents the end of the first stage in the study – the technical fact finding and initial analysis. The next stage is to gauge reaction from the amateur population. The report floats a number of ideas; some may be considered controversial, but as yet no decisions have been taken. ***Don't take this report as RSGB policy yet!***

PREFACE by Malcolm Appleby G3ZNU (Chairman, VHF Committee)

12·5kHz CHANNELISATION ON 144MHz

During the last 25 years there have been several important changes to band planning, all of which initially caused a certain amount of expense and trouble, but which ultimately proved advantageous to operators. The introduction of ssb around 145·3MHz, with the abandonment of the original area band plan, was definitely an advantage, and promoted the use of vfo's and co-channel operation of QSOs, thus saving band space. Later, fm developed with favoured frequencies, including 144·48MHz, for example. Many rigs were crystal channelised on six frequencies or so, but these all had to be re-crystalled with the introduction of repeaters, and the new band plan above 145MHz. Hundreds of Liner 2s had to be re-crystalled from 145·3MHz down to 144·3MHz to conform to the new ssb allocation below 144·5MHz. This released 145·3MHz, and the segment around this frequency, for fm channels. Beacons used to be at various frequencies across the entire band, but eventually they were all grouped between 144·845 and 144·99MHz. The satellite band was originally around 145MHz, but this shifted to the top of the band by agreement with IARU.

The proposal to double the channel density appeared pretty daunting at first, but as the months went by, the VHF Committee recognised the urgency for a study. Taking a broad view of the 144MHz band, there are not enough fm simplex channels available in at least three large areas of the UK, specifically Greater London/Home Counties, West Midlands, and Merseyside/Greater Manchester. A close examination of the band segment 145·0 to 145·775, (Table 1) shows that there are only eight simplex frequencies available without reservation. Six have some reservation, and two channels have serious reservations in their usage. Moreover, 17 channels cannot be used for simplex, as they are set aside as repeater inputs/outputs or various calling frequencies. The serious congestion that sometimes exists in many highly populated urban areas is a nuisance to 144MHz fm users, and this article deals with various ways in which the problem can be alleviated.

THE PRESENT SITUATION

Taking the Greater London area as the most obvious example, there are frequent periods in which several QSOs are in progress on the same frequency, where the capture ratio phenomenon has to be used, hopefully, to reject unwanted stations. Many nets are now occurring on either 12·5kHz channels, referred to as X channels, or on channels spaced rather haphazardly perhaps ±10kHz from 25kHz chananels.

Quite often amateurs can be heard using frequencies in the beacon and satellite bands in sheer desperation, and just as alarming is the occasional use of frequencies below 144·5MHz for fm. The sheer size of the problem in congested areas, particularly in London, is causing some amateurs to use non-recommended channels. Many modern rigs can accommodate the X channels physically, but hardly any are set up electronically for compatible X channel usage, ie, they have too high a peak deviation, and the incorrect if filters.

There is no problem at all with fm on the 432MHz band, fortunately, but the fact is that most fm operation is on 144MHz.

BAND USAGE

The officially channelised part of the band from 145·000 to 145·775MHz is not subject to much misuse, and only rarely have modes other than fm been heard in this section. The band from 144·500 to 144·845MHz has, however, been designated "all modes non-channelised". All the frequencies in this section designated for specific users are, for convenience, chosen to be at 25kHz. Almost all fm rigs on the market can accommodate 25kHz steps, and are thus fully compatible, but many nets have chosen to use frequencies in between the 25kHz steps in order to try to find a space somewhere, but since some of these frequencies are offset by only 10kHz, rather than 12·5kHz, severe interference problems are arising. During the last three years or so, many nets on 12·5kHz frequencies have been introduced in between the 25kHz ones to get over the problem, which has become more severe as one 25kHz frequency after another has been set aside for special usage, eg 144·650MHz for packet repeaters, and 145·300 for afsk rtty. All too frequently, inexperienced amateurs have even used the beacon band and repeater output channels when they cannot hear signals in these segments, forgetting that others may well suffer serious interference by such usage. Some amateurs, who have used 12·5kHz X channels in desperation, have caused interference to 25kHz channelled stations by using excessive deviation, and through receiver i.f bandwidths being too wide.

SOME SUGGESTED REMEDIES

There are three main solutions to consider for alleviating the problem. There is no reason why all three could not be employed at the same

TABLE 1
FM Channel Information on 144MHz Band
Availability key.
A: FM simplex is totally unacceptable.
B: FM simplex is only acceptable if it is not even likely that the channel might be in use in your area.
C: Useable for FM simplex, provided channel is not in use locally.
D: FM simplex can be used at any time within the normal licence conditions.

144·500	B	SSTV calling	N
144·525	C	used by HF DX warning net	O
144·550	D		T
144·575	D		
144·600	B	RTTY calling and working	O
144·625	B	Misc. data working	F
144·650	A	packet repeaters	F
144·675	A	packet working	I
144·700	C	fax calling	C
144·725	D		I C
144·750	B	ATV talkback, calling and working	A H
144·775	C	Raynet working	L A
144·800	C	,, ,,	L N
144·825	C	,, ,,	Y N
144·850	C	,, ,, (within beacon band)	E
144·875	C	within beacon band	L
144·900	A	beacons	I
144·925	A	,,	S
144·950	A	,,	E
144·975	A	,,	D
145·000	A	repeater input	
145·025	A	,, ,,	
145·050	A	,, ,,	
145·075	A	,, ,,	
145·100	A	,, ,,	
145·125	A	,, ,,	
145·150	A	,, ,,	
145·175	A	,, ,,	
145·200 (S8)	C	Raynet	
145·225 (S9)	C	used by Raynet occasionally	
145·250 (S10)	C	slow morse practice	
145·275 (S11)	D		
145·300 (S12)	B	RTTY AFSK	
145·325 (S13)	D		
145·350 (S14)	C	used by RAIBC National Net	
145·375 (S15)	D		
145·400 (S16)	D		
145·425 (S17)	D		
145·450 (S18)	D		
145·475 (S19)	D		
145·500 (S20)	A	FM simplex calling channel. No QSOs, always QSY	
145·525 (S21)	C	GB2RS Sundays, and on some other occasions	
145·550 (S22)	C	talk in to various events	
145·575 (S23)	D		
145·600 (R0)	A	repeater output	
145·625 (R1)	A	,, ,,	
145·650 (R2)	A	,, ,,	
145·675 (R3)	A	,, ,,	
145·700 (R4)	A	,, ,,	
145·725 (R5)	A	,, ,,	
145·750 (R6)	A	,, ,,	
145·775 (R7)	A	,, ,,	
145·800 (R)	B	occasional use from satellites	

Availability	A (totally unavailable)	17
	B (serious reservations)	2
	C (slight reservations)	6
	D (completely available)	8

NB: Availability D could become approx 42 channels with 12·5kHz channelling.

time, for each could have a significant effect on the problem.

1). Encourage more amateurs to use the 432MHz band at times of high 144MHz band usage.

This would be an excellent solution, but the disadvantage is that rigs for the 432MHz band are more expensive, and coverage is generally poorer, which significantly decreases the potential range for any given station, mobile or fixed. It would be difficult to encourage a dramatic increase in activity on a band that is, frankly, rather poorly populated at the moment, even in the London area.

2). Use significantly lower power levels on 144MHz in urban areas at times of high band usage.

It is appreciated that poorly located stations may need higher powers and better receivers than those in better locations. A mandatory power limitation for fm in urban areas would be unwise, but amateurs could be persuaded to use lower powers than they already do for a higher percentage of their contacts. This would allow many more QSOs to be co-channel, without significant interference. Many amateurs already are using less power, but this is only a partial solution to the problem.

3). Change over to a nominal lighter channelling standard for fm operation on the 144MHz band.

This solution has already been adopted in the US with the approval and use of 15kHz channelling instead of 30kHz. Considering the overall quality of the system, 15kHz is probably the closest channelling that can be used with most existing rigs without major modifications. However, a change to 15kHz would seem to be unwise, because it would be more complex to achieve than 12·5kHz channelling, bearing in mind existing 25kHz channelling in the UK and Europe. Most new rigs do have a 12·5kHz channelling facility, although not many have appropriate filters. Yaesu and Icom filters are all basically designed for 25kHz channelling, but some Trio rigs are normally fitted with "F" filters suitable for 15kHz channelling. (See appendix for filters.)

If the 12.5kHz option is considered, there would be a total of 24 potential simplex/fm data, etc, channels, together with eight new repeater channels, all between 145·0 and 145·7875MHz. There's no doubt that 12·5kHz channelling would alleviate the problem quite well.

MODIFICATIONS TO RIGS

Rigs which at present exclude the selection of X channels may well be modifiable by changing synthesiser crystals, microprocessors, or microprocessor connections. Many rigs can be switched to within ±500Hz of the correct X channelling, which should be adequate. Whereas rigs using "F" filters might have just acceptable selectivity, the large majority having "E" filters will require "F" or "G" filters as a replacement. Some rigs will benefit strongly by having the first i.f roofing filter changed to a narrower type too. The main synthesiser crystal, or conversion crystal, may have to be readjusted for improved frequency accuracy. Although some rigs may physically be modifiable, frequency displays could be awkward to modify.

Transmitter deviation will have to be readjusted for around 3kHz nominal, and 3·5kHz absolute max. Some tone burst deviations will require separate adjustment. Mic amp gains may also need adjustment, and in some cases fixed resistors may need to be changed for ideal results. A few rigs will require additional hf roll-off above 3kHz to avoid high modulation indices. Very careful readjustment of discriminators may also be necessary, in some cases, to improve system distortion, capture ratio, and ignition interference rejection. In a few instances slightly more audio gain will be required on rx when full audio gain is inadequate to fully drive the output amplifier. It is hoped that most amateurs will be capable of performing these mods, but there is no doubt that traders will have much work to do during a change-over period!

COMPATIBILITY OF RIGS THAT CANNOT BE MODIFIED FOR X CHANNEL USE

Rigs in this category will at least require deviation reduction on tx in order to avoid causing interference to those using X channels. They will need a narrower i.f filter so that their users will not themselves receive interference from X channel transmissions; an unmodified rig of this ▶

type will reproduce some spitchiness and interference from adjacent X channels. Amateurs moving from an urban area where they were used to using X channels could inadvertently cause problems to others in areas of low amateur populations where many unmodified rigs may still exist. Tact will be needed here, because wider deviations will also interfere with the use of X channels by visitors. A willingness to QSY readily will be the key.

COMPROMISE BETWEEN RX SELECTIVITY, SYSTEM QUALITY AND TX DEVIATION/RESPONSE

The overall system signal-to-noise ratio varies directly with the system deviation and the square root of the selectivity bandwidth. The available frequency response is also dependent upon selectivity, because high frequency sidebands reduce as filter bandwidth is decreased. If we choose the normal PMR standards of 2·5kHz maximum deviation, and "H" filters with around 6kHz bandwidth, there will be a significant degradation of overall signal-to-noise ratio and subjective sensitivity. However, for an amateur radio service we do not need the almost 100% protection required by PMR, and therefore a degree of adjacent channel interference is tolerable. This will allow greater flexibility, less expensive grade of filtering, and slightly higher deviation in the system, which reduces the effects of the change on overall system quality. A choice of around 3kHz nominal deviation, with 3·5kHz absolute max, and filters of around 10 to 20kHz bandwidth, will allow a degree of compatibility when modified rigs interact with unmodified ones. This should lead to rather less criticism of the change. Repeater inputs and outputs will be subject to tighter tolerances, especially of output deviation, to enhance the separation of adjacent channel repeaters.

FACTORS FOR A CHANGE

1) Potentially over 24 working simplex channels without reservations, instead of the existing 8.
2) Any simplex channel adopted by a local group would be less likely to be opened up by casual users or visitors.
3) More repeater channels would be available, and hence a larger number of repeaters could be operated in the largest conurbations to spread the load.
4) The additional repeater channels could allow a reduction in the number of co-channelled repeaters covering partly shared areas, eg GB3VA/GB3KN and GB3SN/GB3DA. It is most unfortunate that many stations receive two repeaters on the same frequency at almost equal strength on a mobile whip.

APPENDIX
MURATA FILTER CLASSIFICATION

Suffix	6dB bandwidth
E	15kHz
F	12kHz
G	9kHz
H	6kHz
HT	6kHz

Insertion loss usually between 4 and 8dB. IF 455kHz. 60dB bandwidth dependent on prefix type. Input/output impedance usually between 1·5K and 2K ohms. Selectivity highly dependent on quality of filter designated usually by final letter of first prefix group.

5) Any amateur using one of 24, rather than 8, channels should be more able to have a QSO with a distant station without interference, as the frequency would be more likely to be free. It might be thought desirable to recommend 25kHz channels for more distant QSOs, and X channels for more local ones.
6) Develop a system to have wide coverage repeaters on 25kHz channels, while reducing X channels for coverage repeaters, allowing a higher density of them in a large area.
7) The slightly reduced system quality on 144MHz might well encourage man amateurs to make more use of 432MHz with its higher deviation potential, and the wider allowable frequency response than 144MHz.
8) More use could be made of the new automatic channel identification, QSY, and rig identification systems, which have been introduced by various Japanese manufacturers. There would be more point in seriously considering the use of sub-audible tone squelch and other facilities, as any given channel is more likely to be free from casual use. A group of stations could make good use of these facilities if their channel is less likely to be interrupted.
9) The provision of so many additional channels would be a strong discouragement to the use of inappropriate frequencies for simplex operation, thus giving better protection to the beacon, satellite and SSB band segments.
10) At present, stations using X channels tend to cause interference to those on 25kHz ones. X channel stations with reduced deviation will definitely cause less interference even to 25kHz channel users with unmodified rigs.

AGAINST A CHANGE OF CHANNELLING

1) Some rigs cannot be modified to cope with X channels. They may even be crystal controlled independently for each channel, but the cost of crystals is now very high, and some rigs would not have enough spare positions to cope with additional repeaters etc.
2) Some rigs would be difficult to modify, and narrower i.f filters may not be available or viable for them.
3) Although many rigs could be converted at a low cost by their owners, dealers might well charge £20 or more – mostly for labour – which would be a burden for some.
4) The necessity of conversion would cause a degree of resentment by many amateurs, especially those living in areas of low activity.
5) Modifications may have to include a degree of additional audio hf filtering on tx, as well as lowering the deviation.
6) Developing a system to have wide coverage repeaters on 25kHz channels, while reducing X channels for coverage repeaters, allowing a higher density of them in a large area.
7) The overall system audio quality would tend to be degraded with a slightly reduced frequency response in some cases, and perhaps an inferior subjective sensitivity. There would be approximately 1·5dB SINAD sensitivity degradation. This could be partly offset by more attention to the use of pre-amps, and the gradual change from old rigs to new ones. The peak distortion of 12·5kHz compatible stations will be somewhat higher at high modulation frequencies, even with lower deviations. A careful choice of rx filter bandwidths will be required.
8) Amateurs using old rigs may note degraded signal-to-noise ratios when working stations with the decreased transmitted deviation. They will also be subject to more interference from stations using X channels in their vicinity.
9) Repeaters will all have to be modified to cope with the new channelling. This may have to include improvements in frequency accuracy.
10). There may be a few complaints about the reduced fringe area coverage of repeaters. Again, this can be partly offset by improvements in receivers and antennas.
11) Much help will be required in organising deviation meters to be on tap at rallies, conventions and various club meetings to allow as many amateurs as possible to readjust transmitted deviation. Insurance premiums may be required to cover use of expensive equipment.
12) The bulk purchase of quantities of new i.f filters compatible with a reasonable selection of rigs may have to be funded initially by clubs.
13) Traders would have to be encouraged to look into as many modifications as possible, and perform them as reasonably as possible, and without too much delay. This may mean the adoption of a programme which will prolong the overall time in which a changeover is made.
14) Dual band rigs modified for 12·5kHz channelling on 144MHz will give a degraded potential system quality when used on 432MHz. This will be to the disadvantage of rigs such as the Yaesu FT2700, Icom IC3200, and Kenwood TS770, TS780, TW4000A and TW4100E. Even the Yaesu FT727 dual band walkie talkie will be compromised.
15). Susceptibility to ignition noise will be increased, and capture ratio is likely to be degraded slightly with the change to narrower spacing.

IN CONCLUSION

The encouragement to shift to 432MHz operation should be pursued, although an increase in 432MHz band popularity will probably be rather too slow to help the 144MHz situation. The use of lower power may well help in some areas, and it is hoped that as many fm users as possible will try and use lower power to reduce congestion, especially in London. It's fully realised that regular nets with members over a very large area, such as my own RAIBC Friday night net on 145·35MHz, require the use of more power to allow every net member to hear everyone else. Rechannelling at 12·5kHz intervals seems to be the best single solution for the reasons outlined, and straw polls already show that the shift to 12·5kHz channelling would be a lot more acceptable now than a few years ago. Polls in urban areas, especially in London, show high percentages in favour, and no poll has been less than 50% pro a change. Polls have been made in rural as well as urban areas.

The VHF Committee will appreciate constructive comments about the 12·5kHz project from amateurs who regularly use the fm part of the band. We all feel it important to look to the future, and the new channelling scheme would allow much more scope on the band, which in turn might well encourage more people to take an interest in amateur radio. Any changeover would not be easy, but with good will on all sides, it could be accomplished effectively. Comments should be addressed to the author, G3OSS, QTHR.